

# Markowitz Portfolio Optimization Project Report

## Project Overview

The project applied Markowitz Modern Portfolio Theory (MPT) to analyze and optimize portfolios across sectors during the COVID-19 pandemic (May 2019 - May 2022). The optimization aimed to maximize risk-adjusted returns using Sharpe Ratio while ensuring diversification and dynamic stock selection via technical indicators.

## Sectors Analyzed

Five sectors were studied: E-Commerce, Banking, Automobiles, Aviation, and Oil. Each sector included 7 companies, and performance during the pandemic was analyzed to simulate real macroeconomic stress scenarios.

## Portfolio Optimization Approach

Portfolios were created monthly using an Exponential Moving Average (EMA) crossover strategy. Stocks where 9-day EMA exceeded 21-day EMA were considered bullish and included. Optimization was done using the SLSQP algorithm to determine optimal weights.

## Mathematical Foundation

The objective function aimed to maximize expected return minus a risk penalty based on standard deviation, scaled by a risk aversion parameter (typically between 0.2 to 10). Constraints ensured full allocation (weights summing to 1).

## Technical Stack

Python libraries used include NumPy, Pandas, SciPy (for optimization), Matplotlib (for visualization), and yFinance (for historical stock data).

## Evaluation Metrics

The Compound Annual Growth Rate (CAGR) was used to assess portfolio performance over time. A notable example showed 6.77% CAGR for a selected e-commerce portfolio in June 2019.

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## Insights and Conclusion

The project revealed that most portfolios yielded lower growth due to pandemic-induced stock price drops. However, the strategy allowed identification of relatively resilient sectors and helped study dynamic portfolio behavior under market stress.